

Geolocating South Korea's PRIDE

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PRIDE, or Pyroprocess-Integrated inactive DEMonstration facility, (as a typically forced example of an industrial acronym) is a nuclear reprocessing pilot facility in South Korea. It is not a secret facility: Yukiya Amano, the Director General of the IAEA has visited the facility in person and the safeguards for the facility are being developed with IAEA cooperation.



Yukiya Amano Inspecting a hot box inside the PRIDE facility in 2013.

Easy as 123

Nuclear reprocessing is a big deal, however. Only a small number of states possess [facilities to separate plutonium](#) from spent nuclear reactor fuel. Most of these also possess nuclear weapons, with significant exceptions in Western Europe and the ROK's close neighbour Japan. South Korea maintains that new kind of reprocessing that will occur in the facility, known as pyroprocessing, is 'proliferation-resistant' since at no point is plutonium separated from uranium.

The US government [does not share this view](#), and until last year the bilateral nuclear cooperation agreement between the two countries (known as 123 agreements after section 123 of the US atomic energy act) meant South Korea was [forbidden from reprocessing](#) spent fuel, or enriching fuel. These are potential pathways to a nuclear weapon. Japan, another regional ally, has been [reprocessing and enriching](#) for decades. South Korea also has a burgeoning export market for nuclear power plants after [securing a deal](#) in 2009 to construct four nuclear plants in the UAE and a research reactor in Jordan [in 2013](#).

In the [latest 123 agreement](#), concluded last year, a little more leeway was given to South Korea in pursuing pyroprocessing, although it does not seem to permit the use of real spent fuel in the PRIDE facility. The 'I' in PRIDE stands for inactive and for the last 3 years the facility has been tested with 'simulated' fuel consisting of natural uranium.

KAERI see me?

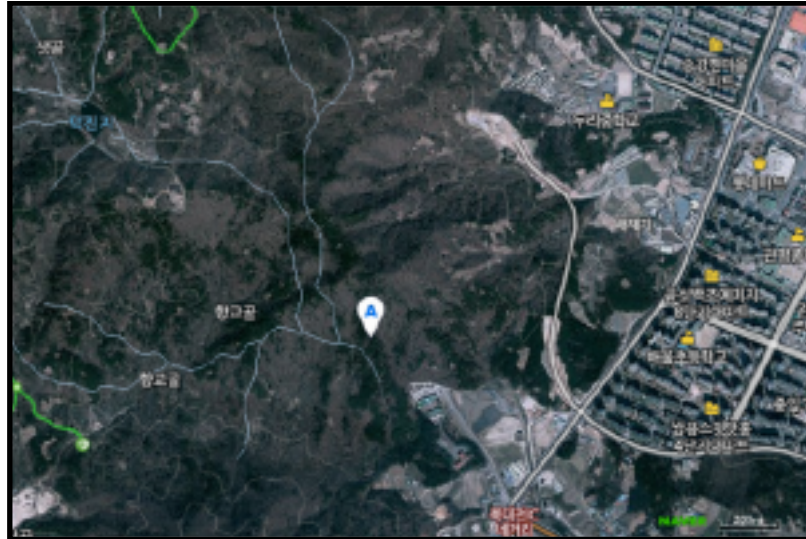
This is all well and good, but the facility itself is not so easy to locate from open sources. The Wikimapia and the Google Earth user generated kmz files I found did not provide the location. A similar blank comes from search engines, wikis and social media I looked at. I know quite a few people that have been there, so the most efficient method would have been to ask, but of course that would take away the fun...

A lot of academic papers have been written on PRIDE, so a [quick google scholar search](#) for 'pyroprocessing' etc. will give plenty of results. Most papers seem to suggest that the facility is at KAERI, the Korean Atomic Energy Research Institute in Daejeon. This can be found fairly efficiently through [Wikimapia](#) at 36°25'29.04"N, 127°22'19.28"E.

However, Wikimapia is little help from there: the only tagged feature inside KAERI is the HANNARO reactor building (the basis for the research reactor in Jordan).

Perhaps other satellite imaging services could help? A Korean maps service called Naver is commonly used in South Korea and Korean colleagues tell me it is better than google

etc. at mapping transport etc. However, use Naver maps to look at KAERI and all you'll get is a view of a nice little forest. The image is from some time in 2012 – we can tell that because in the image the road up to the back of KAERI is still being constructed.



On other mapping programmes, such as Google Earth, KAERI is right there.



Getting Closer

The next step is to confirm that the PRIDE facility really is in KAERI. [A paper published in 2011](#) tells us that it is actually a refurbished uranium conversion facility that

was originally built in the 1980s. It is also kind enough to give us a picture and the dimensions of the building (20m x 40m x 12m).



The article was submitted in late 2010 and a quick reverse image search (right click in google chrome and ‘search for this image’, or do the same with [Tineye](#) after installing the [chrome plugin](#)) finds no earlier images. We also know from the technical literature that the building has three storeys, as can be seen in the picture. Note that extracting the metadata from the photo with [an exif viewer](#) doesn’t give us the geolocation data.

‘Triangulating’ with many Images

This information and picture is probably enough for experienced analysts working with low-resolution satellite imagery to find PRIDE. But it is best to see if there is any other information that can be exploited – in particular more images of the building exterior. With a few image searches for ‘PyRoprocess-Integrated inactive Demonstration’, or ‘pyroprocessing Korea’ a few more images of the facility can be found.

This appears to be the refurbished PRIDE building and looking at the proportions and counting the windows it is very plausible that these are the same building. We could even be looking at the same trees. A reverse image search gives us the latest date for this image as 2011.



A second image of a refurbished PRIDE gives dates for this image as no later than 2013. The staircase on the left of the building, colourings and windows clearly show the same building. The front entrance in the 2011 photo is obscured by the trees but the tan-coloured entrance overhang can be identified as being in the same place on both images. It is not clear if the grass or trees have been removed from the front of the facility, but there is a whole new building behind and to the left.



A final image from a [ceremony to commemorate 'full operation' of the facility](#) is the only dated image we have from 21 December 2015. The various dignitaries are on the left of the building and the staircase and side entrance can be clearly seen. It also appears that the grass as the side of the building has now been removed, which will help when looking at time-stamped satellite imagery. The final bit of information we can get from this picture is a rough estimate of building height. If we say that the guys (yes, they're

pretty much all guys) from this photo are roughly 1.7m tall then the top of the door is about 4 m. Then looking at the 2013 side image we can say this is about 1/3 of the way up the building so we can be pretty confident that the total height of the building is around 12 m. This confirms the height of the original uranium conversion building given in the 2011 paper.



Other obvious open source checks unfortunately don't give any more information. Panoramio and echosec (at least in the free version) reveal no other images.

Looking for Xanadu

All that remains now is to carefully look at satellite imagery of the (rather large) KAERI facility for a candidate building and make good use of Google Earth's timeslider feature.

Google has nine images of KAERI from 30 October 2004 to 24 March 2015. However we know that most of the building work occurred from 2010-2012. In this rough time period Google has just two images, from June 2009 and June 2012. The site as whole changes enormously over this period: I count 20 new structures from 2004-2015, including a whole new road connecting the city to the back of the site.

We know our target is an existing building with x-y dimensions 40m x 20m, with a possible roof change in 2009-2012, near the site of some new buildings. After some careful searching a good candidate appears in the northwest portion of the site.

The image below from 13 June 2009 is a pretty good candidate for our building. The ruler feature in Google Earth lets us measure the building's dimensions, and from this

image I get an approximate size of 42 m x 20 m – which is a pretty good fit. The photo of the uranium conversion facility seems to match features from the satellite imagery rather well. Features that allow us to match include: the two levels at the front of the building, the four trees at the front of the building and the side building. The only feature from the photograph that does not match the satellite image is the tree at the far left of the photo. We can speculate that this tree was removed between the photo and the satellite image. This would also imply that the photo is older than the satellite image.



Google Earth image from 13 June 2009 of the PRIDE building in KAERI, matched with the 2010 photo of the old uranium conversion facility.

Between 2009 and 2012 the roofless building behind PRIDE is finished (which would be obscured from any pictures we have). However, another large building is built on the plot of land behind that and that does seem to show up. This does not appear in the frontal 2011 image but does appear in the side 2013 image. Also we know that the main PRIDE building has had a makeover from both the frontal 2011 image and the side 2013 image which is seen in the satellite imagery in a new roof.



Google Earth satellite imagery of PRIDE on 21 June 2012 with the 2011 frontal image and 2013 side image of PRIDE.

The most recent ground picture at PRIDE shows the ceremony that took place on 21 December 2015. This gives us slightly more information and takes place at side door (shaded above in lime green).



PRIDE on 22 March 2015 with photo from 21 December 2015.

Summary

PRIDE is a functioning facility in KAERI that is working in one of the most interesting areas of the nuclear fuel cycle. Finding it the hard way was a neat little diversion from all the other interesting work we're doing at ICSA.